552 into and through first vapor channel 535*a*, as indicated by arrow 536*a*, into and through process microchannel 520*a*, as indicated by arrow 522*a*. In the process microchannel 520*a*, the vapor phase contacts at least part of the liquid phase in the adjacent wicking region 516. Part of the more volatile component Y transfers from the liquid phase to the vapor phase to form a component Y rich vapor phase. Part of the less volatile component X transfers from the vapor phase to the liquid phase to form a component X rich liquid phase. The vapor phase flows from the process microchannel 520*a* to and through the second vapor channel 540*a*, as indicated by arrow 541*a*, and then to and through process microchannel 525*a*, as indicated by arrow 527*a*. In the process microchannel 525*a*, the vapor phase contacts at least part of the liquid phase in the wicking region 516. Part of the more volatile component Y transfers from the liquid phase to the vapor phase to form a component Y rich vapor phase. Part of the less volatile component X transfers from the vapor phase to the liquid phase to form a component X rich liquid phase. The vapor phase flows from the process microchannel 525*a* to and through the third vapor channel 545*a*, as indicated by arrow 546*a*, and to and through vapor inlet/outlet 554, as indicated by arrow 555. The flow of the vapor phase through the microchannel distillation sections (510, 510*a*) may be driven by a static pressure differential. The flow of the liquid phase through the wicking region 516 may be driven by one or more of gravity, shear force from the vapor phase flowing through the process microchannels (520, 525, 520*a*, 525*a*), capillary forces in the wicking region 516, and a pressure differential within liquid held in the wicking region 516 by capillary forces (e.g., inducing flow from the wicking region 516 by suction after the liquid phase in the wicking region 516 separates from the vapor phase in the process microchannels (520, 525, 520*a*, 525*a*) and is cooled).

[0113] The flow of heat exchange fluid through heat exchange channel 570 may be co-current, cross-current or counter-current relative to the flow of vapor through the second vapor channels (540, 540*a*). The flow of heat exchange fluid through heat exchange channel 575 may be co-current, cross-current or counter-current relative to the flow of liquid through the liquid channel 515. Each of the heat exchange channels 570 and 575 may be used to form a single or multiple temperature zones along the length of the heat exchange channels 570 and 575. For example, a separate heat exchange zone may be employed for each of the microchannel distillation sections (510, 510*a*). That is, each of the microchannel distillation sections (510, 510*a*) may be operated at a different temperature.

[0114] The microchannel distillation assembly 600 illustrated in FIG. 19 is the same as the microchannel distillation assembly 100 illustrated in FIG. 1 employing the microchannel distillation unit 400B illustrated in FIG. 16 except that more detail is provided in FIG. 19. In FIG. 19, microchannel distillation assembly 600 includes process microchannel 610, liquid channel 630, microchannel condenser 680 and microchannel reboiler 690. The microchannel distillation assembly 600 illustrated in FIG. 19 contains n microchannel distillation sections 670, that is, microchannel distillation sections 670, 670*a*, 670*b*. . . 670*n*-2, 670-1 and 670*n*, wherein n is a number that can be of any value, for example, 5, 10, 20, 50, 100, 500, 1000, 10000, etc. The broken space in FIG. 19 indicates that distillation sections 670 beyond those illustrated may be provided. The process microchannel 610 and liquid channel 630 employed in microchannel distillation assembly 600 have the same construction and function in the same manner as the process microchannel 410 and liquid channel 430 illustrated in FIG. 16. A feed comprising a fluid mixture comprising components X and Y enters microchannel distillation assembly 600. Within the microchannel distillation assembly 600, a vapor phase flows through a series of microchannel distillation sections 670 in a direction towards the microchannel condenser 680 and a liquid phase flows through a series of microchannel distillation sections 670 and the liquid channel 630 in a direction towards the microchannel reboiler 690. In each microchannel distillation section 670 the vapor phase and the liquid phase contact each other with the result being a mass transfer between the phases. In each microchannel distillation section 670 part of the more volatile component Y transfers from the liquid phase to the vapor phase, and part of the less volatile component X transfers from the vapor phase to the liquid phase. The vapor phase, which is progressively enriched with the more volatile component Y, flows through microchannel distillation sections 670 towards the microchannel condenser 680 and into the microchannel condenser 680. The liquid phase, which is progressively enriched with the less volatile component X, flows through the microchannel distillation sections 670 and the liquid channel 630 towards the microchannel reboiler 690 and into the microchannel reboiler 690.

[0115] The microchannel condenser 680 illustrated in FIG. 19 comprises portions of process microchannel 610 and liquid channel 630, the latter including a portion of wicking region 632. The microchannel condenser 680 also comprises microchannel condenser space 681, interior wall 682, distillate outlets 683 and 684, and heat exchange channels 685 and 686. The microchannel condenser space 681 may have the same dimensions of height and width as the process microchannel 610. The heat exchange channels 685 and 686 may have the same dimensions as the heat exchange channels 650 and 660. In operation, the vapor phase from microchannel distillation section 670*n* flows through capture structure 672*n*, as indicated by arrow 614*n*, into microchannel condenser space 621 wherein the vapor phase is condensed. Part or all of the condensed vapor phase, which may be referred to as distillate product D, flows from microchannel condenser 680 through distillate outlet 683, as indicated by arrow 687. Part or all of the distillate product D may flow through distillate outlet 684 into wicking region 632, and through wicking region 632 to liquid entrance 676*n*, as indicated by arrow 633*n*. From that point, the liquid phase flows through the liquid channel 630 and the series of microchannel sections 670*n* to 670 towards the microchannel reboiler 690.

[0116] The microchannel reboiler 690 illustrated in FIG. 19 comprises portions of process microchannel 610 and liquid channel 630, the latter including a portion of wicking region 632. The microchannel reboiler 690 also includes microchannel reboiler space 691, liquid inlet 692, vapor outlet 693, liquid outlet 694, and heat exchange channels 695 and 696. The microchannel reboiler space 691 may have the same dimensions of height and width as the process microchannel 610. The reboiler heat exchange channels 695 and 696 may have the same dimensions as the heat exchange channels 650 and 660. In operation, the liquid phase from microchannel distillation section 670 flows through liquid inlet 692, as indicated by arrow 636, into microchannel